to the State; the public has protested in surprising fashion its affection for museums. Recent legislation has recognised this in removing the rate-limit for municipal museums, and in facilitating the promotion of museums by the education authorities of the counties and boroughs. The committee, though it welcomes this change of attitude, does not do so without warning and criticism. It recognises that municipal and national museums are not the only kinds deserving of State- or rate-aid; there are semi-private museums which need it even more. It is a little afraid of control by an "authority" that may know all about education, but certainly knows little about the governance, organisation, and financial needs of museums; and it would like to see "some national or central authority fully conversant" with such matters, to whom local museum committees might turn for advice—or perhaps something still more satisfying. Such welcome as the committee does give to the education authority seems due to its hope that the education grant will pay for the extra material and the special staff required for such desirable works as loan collections for schools or school classes in the museum. It also suggests that recent legislation may find its best fruits in establishing museums in towns as yet unprovided with them.

It is rather striking that, of the five general conclusions emphasised by the committee, the first four have reference to research. In research the universities should co-operate. To aid research, lists of contents should be published. Grants in aid should be proportioned to the research conducted by a museum, no less than to its other activities. Curators must have had a university training, fitting them for research as well as for administration. All this may not seem to have much to do with education. But the committee is right. Granted that the collection and preservation of material objects constitute the *differentia* of a museum, it is clear that the first necessity is the study of those objects. "This research must be prosecuted if museums are to fulfil their highest function, which is the advancement of Science, Art, and Industry." Research is a necessary preliminary to any and every other function of a museum, and not least to the function of education. We cannot deal here with the many practical recommendations scattered through the body of the report, and perhaps not sufficiently distinguished by type or spacing from their context. They should prove acceptable and useful to both educationists and museum officials. We would, however, reiterate our high appreciation of the committee's labours and of the firm stand that it takes on the really fundamental principles.

The chief conclusion we would ourselves draw from this report is that there is a vast body of experience relating to the proper management of museums and their use in education, and not in that alone. Much of it forms the basis of this report; much is to be found in the publications of the Museums Association and in a few books that have been published. But the local authority faced with the task of founding a museum, or of taking over and utilising one already in existence, knows nothing of all this. On this ground, then, but not on this alone, we warmly approve the suggestion that there should be a central council or board, composed of persons with knowledge and sympathy, and endowed with the requisite powers, to watch over and aid the inception of museums, to co-ordinate their work when established, and to bring them into touch with the national museums. Such a council as we have in view would certainly not wish all museums to conform to one pattern or to rigid rules, but it might save much duplication of work and expenditure and much ill-directed effort.

Scientific Methods of Design and Control in Chemical Industry.

Ministry of Munitions. Department of Explosives Supply: Preliminary Studies for H.M. Factory, Gretna, and Study for an Installation of Phosgene Manufacture. Pp. xvi+145. (London: H.M.S.O., n.d.) Price 15*s*. net.

DURING the war an enormous amount of work was done by the Department of Explosives Supply in the design of chemical plant, processes, and works, and in the construction, organisation, and control of the numerous national and other factories dealing with the manufacture of explosives and closely related substances. Lord Moulton, who was Director-General of Explosives Supply, and whose magnificent work in the cause of Great Britain and the Allies cannot be overestimated, was fortunate in having associated with him a devoted band of men of exceptional ability and knowledge. Pre-eminent amongst these on the technical and scientific side was Mr. Kenneth B. Quinan, who was responsible for the design, construction, and organisation of the works controlled by the Factories Branch. Where all worked so splendidly, it might seem invidious to single out one name. But the writer well knows that amongst the hundreds, or indeed thousands, of men who fought the war behind the front so splendidly in the Department of Explosives Supply there is not one who did not look up to "K. B. Q." as the great inspirer and organiser, or who failed to realise what the nation owed to his genius, personality, and indefatigable labour.

Mr. Quinan was also a great educator. One cannot explain this better than by quoting from the excellent preface to the present book.

> "Mr. Quinan introduced methods of studying the various problems which arose and setting out the results, which were clear and very helpful to all who were connected with the erection of the plant and works, or the subsequent manufactures carried out. . . . Mr. Quinan insisted that the steps in a calculation by which certain results were obtained should be set forth so distinctly that they could easily be followed, and that the author himself might be able to trace the line of his reasoning and action after the matter had passed from his attention, without having to rack his brains to see how he had obtained his results. He thoroughly believed in the advantage of letting all those who were engaged in directing and carrying out work have the fullest possible understanding of what they were doing, and this policy bore excellent fruit in the results obtained at the works managed by the Factories Branch, which were carried on under the initial disadvantage of staff and workers largely without expert knowledge of the work they had to do."

In pursuance of this policy, every working drawing was accompanied by a well-reasoned description of the purpose and function of the various parts of the apparatus or plant, and the technical staffs at the various factories were constantly engaged, at Mr. Quinan's instigation, in studying the working of their plant, carrying out laboratory and plant researches, and vying with each other in a continuous process of improvement in the efficiency of the plant and in their understanding of the scientific principles underlying its design and operation.

It can well be imagined that, as a result of these methods, Mr. Quinan accumulated a vast amount of material, scientific and technical, of the greatest value to the nation, and especially to the young men who are destined to become the technical workers and the leaders of the next generation. It was Mr. Quinan's earnest wish that as much as possible of this material should be edited and published after the war for the benefit of the scientific institutions of the country and for all those young men who are already engaged in the chemical industries of the British Empire. It is extremely fortunate for the successful execution of this great work that the Government has entrusted it to Mr. William Macnab, who was a member of the Department of Explosives Supply throughout its whole existence (and of the original Committee of the War Office from which the Department sprang), and very closely connected with its development and with every phase of Mr. Quinan's work.

The present volume is published under the *aegis* of the Ministry of Munitions, but the continuation of the work has been entrusted to the Department of Scientific and Industrial Research, which will publish a number of other volumes. It would be impossible to exaggerate the national importance of this work. To apply scientific principles and data to the development of industrial plant and processes requires just as much scientific method, research, and intellectual labour as the discovery of the general principles and data of science. A failure to realise this, an all-too-narrow interpretation of the words "science" and "research," accounted for many errors in the past and for much of our unpreparedness when the stress of war came so swiftly upon us. There was, however, another factor, and one of cardinal importance. There existed few, if any, examples, accessible to all, and drawn from real practice, of the methods employed by the great scientific designers and creators of industry. How does one design a plant, a process, or a works? Who was there to answer that question? How did the Glovers, Deacons, Hurters, and Monds—to mention only a few great names drawn from chemical industry—set about their work? There were plenty of books on chemical technology, but not a word on the real thing, the method of research, the way to go about it. It is a supremely difficult thing to apply science scientifically and successfully. You are not free to choose your variables, or to eliminate unpleasant ones. The whole universe is on the top of you. You cannot say that you are a chemist and, therefore, do not intend to worry about the physical and engineering aspects of the problem. Unfortunately, a chemical plant is a bit of Nature, and includes, therefore, all the sciences. And Nature is not particularly concerned with the limitations of one's education or one's particular tastes and temperament. It is no doubt perfectly true that a man can learn to be a real technical chemist only by long practical experience in works. But it is of the greatest importance for the training of young men in the later stages of their work at the universities and higher technical schools that those whose capacities and temperaments incline them to industrial work should have the possibility of studying some first-class examples of how scientific principles and data are utilised and developed in the creation of processes and plant.

For the first time in the history of chemical science this is made possible by the publication of these volumes. A close study of this and the succeeding volumes will show the young chemist how physics, physical chemistry, and engineering must be combined with exact chemical knowledge. He will find here large numbers of drawings in plan and elevation which he can utilise in his study of engineering drawing as applied to chemical plant. He will see how, step by step, leaving nothing to chance, the elaborate calculations are carried out whereby from a number of fundamental data the complete flow-sheets and precise working details of large chemical factories are quantitatively developed. He will learn how every technical chemical problem involves much knowledge of physics and engineering, and he will see how much the practical chemical designer has to do with questions of heat absorption and evolution, and the transfer and transmission of heat. Most important of all, he will learn that the object of the truly scientific designer is to guess at nothing, but, if possible, to reduce everything to fundamental principles, precise quantitative data, and systematic calculation.

In the present volume the larger part—*i.e.* that relating to the design of the great Gretna works for the production of cordite and nitroglycerine—presents to the student of chemical industry and chemical engineering a unique object for study. The plan adopted by Mr. Macnab is to set forth systematically all the calculations as to quantities and capacities to be dealt with by the various sections of the plant and works. These calculations are summarised in a complete series of flow-sheets. The various sections and the general lay-out are illustrated by a large number of engineering drawings, all of which are accompanied by detailed descriptions which add enormously to their value. The "Study for an Installation of Phosgene Manufacture" is a fine piece of work, and an excellent example of Mr. Quinan's method of utilising thermo-chemical and physical data in the solution of a technical chemical problem. This "study" is a little classic, and will undoubtedly prove a source of inspiration and instruction of the very highest value. The student can here see for himself how, given certain chemical and physical data, the trained and experienced chemical designer sets to work to decide between the claims of rival processes and to develop the technical details of the selected one.

Mr. Macnab is warmly to be congratulated on the splendid way he has carried out his work. The intellectual and manual labour involved must have been very great, but they are justified by the excellence of the result. It can be stated with certainty that the present volume and its successors will constitute a handbook of applied chemical and physical science without its equal in any language. The effects as regards the scientific training of the new generation of chemical students will be far-reaching. The Explosives Supply Department had to produce in gigantic measure the chemical weapons of destruction. In these volumes the work of the Department will live for many years to come as a great and noble contribution to the edifice of reconstruction. It is earnestly to be hoped that the Government Departments now concerned will realise the vast importance of this undertaking and so publish ample editions of the various volumes. There exists here a splendid opportunity of extracting good from the terrible waste of war, and of sowing seed which will produce a rich harvest in the years to come.

One cannot put this volume down without thinking of the great days when Mr. Quinan worked at Storey's Gate. The unique professional knowledge derived from many years of technical experience, the unremitting work of a powerful and vigorous mind, and the irradiating influence of a great, genial, and unselfish personality were unreservedly put at the disposal of the British Empire. An atmosphere of good fellowship and of equal comradeship in work pervaded every branch. Everyone who came under the influence of Mr. Quinan was stimulated to put forth his best in the general cause.

These volumes will constitute an enduring memorial to the work of one of America's greatest sons, a man who did as much as anyone to win the Great War, and in doing so won the respect and affection of all who knew him.

F. G. DONNAN.

Experimental Science in India.

The Life and Work of Sir Jagadis C. Bose: An Indian Pioneer of Science. By Prof. Patrick Geddes. Pp. xii + 259. (London: Longmans, Green, and Co., 1920.) Price 16*s.* net.

THE author of this biography was fortunate in his subject: it was no hard task to write an interesting chronicle of so eventful a life and of so striking a personality. Sir J. C. Bose is equally fortunate in his biographer: his life and work are set forth with conspicuous literary skill, scientific knowledge, and sympathy with the East. The result is a singularly instructive and eminently readable book.

The story of his life shows that Sir J. C. Bose had to contend, at all stages, with difficulties of every kind. The first and most fateful was that